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TANK IRRIGATION IN INDIA AND THAILAND: AN EXAMPLE OF COMMON PROPERTY RESOURCE MANAGEMENT

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K. William Easter and K. Palanisami*

Although most of the tanks of south India and northeast Thailand are nominally the responsibility of government, in practice they are managed as common property resources.[1] These small reservoirs (tanks) irrigate anywhere from a few hectares to over 2,000 hectares and some serve more than 1,000 farmers. In the southernmost state of India, Tamil Nadu, there are almost 40 thousand tanks irrigating 910 thousand hectares. Many of these are at least 100 years old while the tanks in Thailand are much younger and fewer in number. In both countries tanks are used to irrigate rice during the wet season and a small acreage of dry season crops.

There is a wide variation in the effectiveness with which the tank water is used. Most of the irrigation facilities are, in some degree, jointly operated and cooperation is necessary if one farmer's overuse or misuse is not to subtract from another's use. Problems of coordination and cooperation generally become apparent when significant changes occur in the pattern or level of water use which are often associated with increased water

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[1]Most of the examples given in this paper refer to south Indian tanks since our data base for these tanks is better than the one for the tanks of northeast Thailand.

scarcity. In many of the tanks in south India, water scarcity and the need for cooperation is the rule rather than the exception.

If the users are unable to cooperate in the use of the resource then conflict-oriented competition emerges resulting in quick exhaustion of the tank water supplies. Several attributes and relationships influence the use of tank water and help decide the overall management of the tank systems. In this paper, these attributes and relationships are analyzed in terms of the model developed by Oakerson [1981]. The model has four components -- technical/physical attributes, decision making arrangements, pattern of interaction and outcomes. Each component is analyzed using the tank management characteristics of a sample of ten tanks in south India (Tamil Nadu State) and seven tanks in north-east Thailand.

Technical and Physical Attributes

South India

Each farmer in the tank command area is potentially eligible to receive water supplies from the tanks in proportion to the farm size until the tank water supply is exhausted. The limiting condition in the use of tank water in south Indian tanks is the storage capacity of the tanks and quantity of water available to fill the tanks. Some of the tanks are filled more than once a year while others may be completely filled only once in every four or five years.

Tank siltation and agricultural encroachment in the tank foreshore area have reduced the storage capacity of many of the tanks, thus reducing water supplies (see Figure 1). The location of the sluices (outlets) in the tank, either upper or lower, also affects the amount of water delivered to farmers. The upper sluices in the silted tanks cannot provide water unless the tank water level is high. In years when the tank water supply is inadequate farmers served by upper sluices may get little or no water.

In years of water shortages farmers in the tail-reaches of the system are <u>excluded</u> by virtue of their location. What little water they receive will arrive late. Sometimes this exclusion by location is due to poor design: two of the ten Indian tanks were constructed based on a faulty design which placed the sluice gates below the level of the upper command area. Thus the farmers in the upper command area are excluded because of their location even though the two tanks store enough water.

The other physical constraint, which influences the water supply and the amount of exclusion because of location, is the source of water. The primary tanks have water rights on perennial sources of water such as large rivers or reservoirs and have adequate water supplies to irrigate one crop for all farmers in the command area. In contrast, supplementary tanks suffer frequent water shortages since their main source of water is run-off from rainfall. Thus, farms in the tail-reaches of the areas

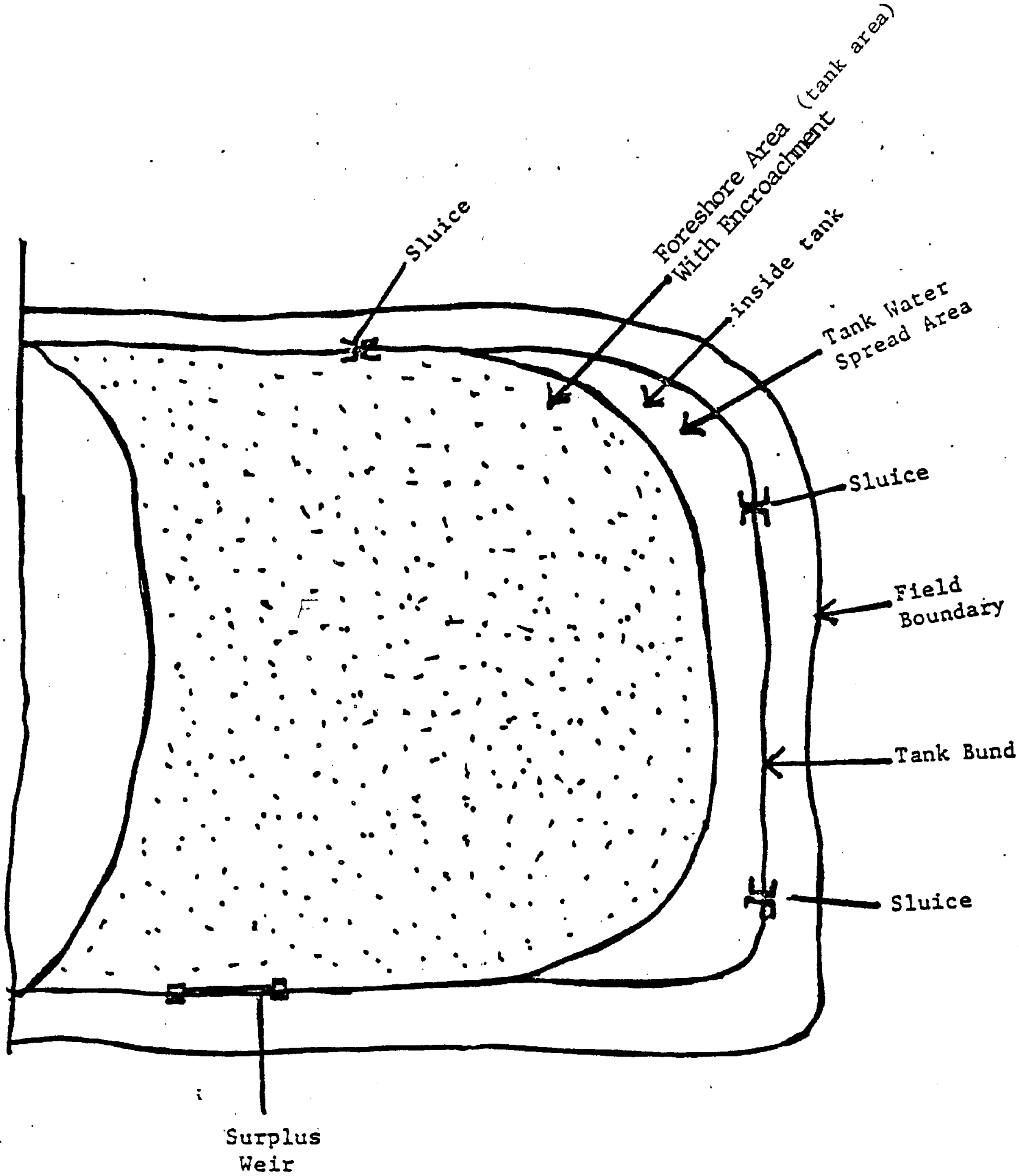

FIGURE 1. Tank with Severe Encroachment and Sedimentation.

irrigated by supplementary tanks will be frequently excluded because of location.

The installation of private and community wells in the tank irrigated areas have helped overcome some of the water supply constraints in the south Indian tanks.[2] Return flows from surface irrigation and the tanks themselves recharge ground water. Thus the wells allow farmers to re-capture some of the water lost through excessive irrigation.

Comparison with Thailand

For the tanks of northeast Thailand, the major technical and physical constraint is the inadequate distribution system which is improperly operated. Although the government constructs the tanks and provides the main canals for large tanks, the laterals and field channels are the farmer's responsibility. In most cases the channels and laterals have never been constructed while the main canal is allowed to deteriorate because of little or no maintenance. In some of the smaller tanks not even a main canal has been constructed.

Thus for the tanks in Thailand the problems are primarily below the tank outlets while those in the south Indian tanks tend to be above the outlets. This is because the tanks of northeastern Thailand are mostly less than 20 years old while many of the south Indian tanks have been in operation for over a century. The age difference has resulted in a significant

[2]There is little or no well irrigation in northeast Thailand because of saline groundwater.

difference in the physical and technical problems. The above the outlet problems facing south Indian tanks appear to be more difficult for community organizations to solve because of the large investments required and the conflicts over land rights between tank irrigated farmers and farmers encroaching (planting crops) in the water storage area [Palanisami and Easter, 1983a].

The tank investment is a typical <u>indivisible</u> large investment. However, the rights to the water in the tank can be divided and those rights can be either public or private. Thus, the indivisibility aspect does not necessarily pose any special problems to resource management once the project is built. The one exception to this is canal maintenance. Responsibility for maintenance of canals serving more than one farmer must be agreed upon and enforced. Does the person at the end of the canal have to maintain the whole canal while those at the head only maintain the upper part of the canal? How should the responsibilities be divided to maintain this indivisible asset? This is a problem which plagues many irrigation systems all over the world [Easter, 1985].

Finally the boundary of the resource demand is defined on the physical side by soil, hydrology and the construction of the tank and canals. The irrigated area must be downhill and a reasonable distance from the tank and the canals. On the supply side the resource is defined by the capacity of the tank and the source of water. The capacity of the canals can also place a limit on who gets water during peak irrigation periods. But when the source of water is a large river, and the delivery system is ample then there are few water supply constraints except in drought years and _jointness_ in supply exists. However, the supplemental (rainfed) tanks of south India have frequent water shortages and jointness does not exist, in many cases, since one farmer's use may subtract from the supplies of others.

Decision Making Arrangements

Collective Use (India)

Certain decision making arrangements result from the nature of technical and physical constraints. With the main objective of the farmers to obtain their share of the tank water supplies, various decision making arrangements or rules have evolved both at the tank and farm levels.[3] The conditions for collective use arise when tank water scarcity occurs forcing farmers to compete for their share of water. The best example of collective use is the informal water user organization at tank level. There exists a strong relationship between the degree of water scarcity and the activity level of water user organizations (WUO). During periods of water scarcity the benefits from cooperation rise and so do the activities of the WUO. Even in the primary tanks where water is usually not scarce farmers cooperated during the 1983 drought. They implemented a water rotation schedule to conserve their limited tank water supplies.

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[3]Share is usually defined in terms of the acreage irrigated. Thus farmers with the largest acreage generally receive the largest shares.

A second condition for collective use at tank level is a reasonably uniform distribution of benefits. One measure of this uniformity is the farm size variation within the tank command area. The sample of ten Indian tanks shows that the smaller the variation in farm size, the more farmers participate in organization decisions and the more likely they are to form WUO (see Table 1). When farms are about the same size, farmers will obtain approximately equal benefits and have equal interest and influence on decisions concerning the allocation of inadequate tank water supplies.

Finally, trusted leadership in the WUO is a key factor in the success of tanks both in India and Thailand. The leadership must be effective in organizing community irrigation activities and honest in the handling of community funds used for irrigation. In a number of tanks in Thailand inadequate finances and/or the misuse of finances caused WUO to fail or become inactive [Tubpun, 1981; Russell and Nicholson, 1981, p. 51-52].

Operating Rules (India)

The collective use of tank water requires a set of basic operating rules. For the south Indian tanks these rules include the following:

1. Rotation schedules for tank water and individual canals.
2. Water release and closing dates at the tank (see Table 2).

Table 1

Tank Management in Relation to Farm Size Variation and Farmer Organization, South India, 1982

Tank No.	An Active Water Users' Organization	Average Farm Size (acres)	Farm Size Variation[a] (percent)	Overall Tank Management
1.	Yes	2.0	31	Good
2.	No	3.1	66	Adequate[c]
3.	No	2.5	51	Adequate[c]
4.	Yes	1.3	24	Good
5.	No	2.0	86	Poor
6.	No	1.9	72	Poor
7.	No	1.9	91	Poor
8.	No	1.9	91	Poor
9.	Yes	1.1	33	Good
10.	No	2.3	104	Poor

[a]This is the coefficient of variation (C.V.) in farm size.

[b]Overall tank management is based on a subjective judgment of the tank's operation in terms of water storage, water allocation, water conflicts and crop yields. It is a comparative judgment among tanks.

[c]Tanks 2 and 3 are primary tanks and have surplus water in most years. Thus little water management was required to achieve high yields in 1982.

SOURCE: K. Palanisami and K. William Easter, 1983.

Table 2

Starting and Closing Dates and Total Days
of Irrigation for Tanks, South Indian, 1982

Tanks		November 1981	December 1981	January 1982	February 1982	March 1982	Total days of tank Irrigation[a]
Tank 1	S	27th	6th				11
	C						
			2nd	10th			
Tank 2	S	4th continuous supply for 6 months					
	C						
Tank 3	S	9th continuous supply for 6 months					
	C						
Tank 4	S	20th					
	C		10th				21
Tank 5	S	16th					
	C				20th		96
Tank 6	S	22th					
	C				18th		89
Tank 7	S	29th					
	C		20th				22
Tank 8	S	26th					
	C		23rd				28
Tank 9	S		1st	25th			
	C			18th	11th		67
Tank 10	S	17th	17th	6th			
	C		10th, 30th	22th			55

S - Starting tank irrigation
C - Closing tank irrigation

[a]The days of irrigation refer to one crop season.

3. A minimum water level in the tank for fish production.

4. Canal maintenance charges in rupees and/or man days of labor to be provided by each farmer according to the farmer's location and area owned.[4]

5. Sanctions and penalties against farmers who violate the tank water management rules.

Several additional rules are introduced during periods of extreme drought: (1) rules for sharing well water when demand exceeds capacity, and (2) priorities concerning tank water use for those who cannot obtain well water due to their location.

The rules for tank water rotation are usually activated once the tank supplies are known to be inadequate. In general, the operating rules did not exist in the following cases: (1) where farmer conflicts prevent cooperation (tank 10) and when tank water supply is in surplus (tanks 2 and 3 in 1982).

In only three of the south Indian tanks were all five of the operational rules in effect. These were the three tanks which had WUO. However, most of the sample tanks from India established tank water release dates and made collections for mainte-

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[4]Originally the contribution of labor by the farmers for tank maintenance and repair was a regular feature (called Kudimaramathu which means cooperative repair work) but it is not prevalent among Indian tank users today.

nance. One of the two primary tanks established a minimum water level for fish production.

Sanctions and penalties are used only in tanks with WUO. Those who violate the water management rules are deprived of tank water or required to pay a fine of Rs 20-30 per acre. When police cases are filed against violators the leaders of the WUO usually intercede and resolve the problem.

The president of the WUO informally nominates one farmer in each distributory (secondary canal) to monitor the water distribution and collect fees and solicit labor for canal and tank maintenance. These representatives report to the president if any problems arise. The WUO members usually meet once every two weeks or so during the irrigation season to deal with problems. The frequency of meetings usually increases during the end of the cropping season when the water supply is low and irrigation critical.

External Arrangements (India)

The abolition of ownership rights to private tanks and the takeover of the tanks by the Government of India from the Zamindars after India's independence made the tanks a common property resource. The farmers owning land in the area served by each tank have the right to use the tank water. The Tank Restoration Scheme which was established to survey and improve the physical tank structures helped to fix standards for each tank for future structural improvements. The government also provides grants for periodic tank maintenance above the outlet.

Maintenance below the outlet is the responsibility of the farmers. However, government funds available for maintenance are less than what is required to prevent a general deterioration in the physical structures. One reason why this occurs is that there is no relationship between the water fees government collects from farmers and the budget allotted for maintenance of each tank. The water fees collected become part of the general government revenues while maintenance funds are allocated to each administrative division of the Public Works Department on an arbitrary basis. The funds provided each division tend to be allocated to tanks with emergency repair needs and minor repairs are usually neglected.

The actions of the state government of Tamil Nadu which have had a critical impact on tank management involve; the issuing of patta (rights to land) to encroaching farmers, the introduction of social forestry inside the tank water storage area and the implementation of tank rehabilitation measures. Encroachment on the tank foreshore area is a very common and serious problem in tanks which do not fill to capacity in most years (see Figure 1). Farmers have gradually cultivated the tank foreshore or water storage area until as much as 20 to 50 percent of the area is now cultivated in many tanks. After crops are grown in the foreshore area for several years cultivators begin establishing their rights on these lands [Department of Agricultural Engineering, 1982]. The cultivators petition the government requesting that they be allotted some of the foreshore area arguing that the lands are idle. The government, after receiving a number of petitions from cultivators, issued patta to these farmers. This right is called kulamkorvai patta under which the tank foreshore lands legally became cultivated lands [Palanisami and Easter, 1983]. The government's decision encouraged encroachers to expand their cultivation of the foreshore area. In one of the sample tanks this resulted in conflicts between encroachers and tank irrigated farmers, resulting in inefficient tank water distribution and low crop yields.

The government also intervenes in tank management through the farm forestry program for planting trees on vacant lands which includes the tank foreshore areas. Currently this program is initiated by the Government of Tamil Nadu through the State Forestry Department with funds from the Swedish International Development Agency. *Acacia arabica* trees are grown on a 10 year rotation. Farmers feel that in about ten years the trees planted in the foreshore areas will be large enough to reduce the tank water storage capacity and make it difficult to desilt tanks. Thus the social forestry program may have some negative impacts on tank irrigation which are being ignored by the Tamil Nadu State Forestry Department.[5]

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[5]Both the encroachment and the problems created by farm forestry might be eliminated if the WUO had legal status. If they were considered legitimate by government then they could more effectively argue their cases against the misuse of farm forestry and encroachers. Currently only one of the three WUO is a legal entity and it is the most effectively managed tank.

In recent years, there has been more interest in improving crop production from tank irrigated areas. Since many tanks are supplemental tanks, measures to increase the water supply delivered to the farmers' fields are being tried. In selected tanks the government has introduced rehabilitation measures including the lining of the main canals and the provision of community wells. Community wells have been installed in two of the ten sample tanks and canal lining was completed in another. All of these investments had rates of return equal to or better than investments in the private sector [Palanisami and Easter, 1984a].

Comparison with Thailand

For north Thailand, the conditions for collective use were not as strong as they were in south India. The tank systems are primarily less than 20 years old and are used to provide three to four wet season supplementary irrigations for rice. Since the tank water supply is usually in excess of demands for irrigation water during the wet season, farmers have little incentive to conserve water. However, in some tanks delivery schedules are developed for all or part of the command area. Usually project officials, the village head, informal groups of farmers and water user organizations (when they exist) establish the schedules both for the wet and dry seasons [Apinantara and Sriswasdilek, 1986].

During the dry season water is scarce and there is a stronger incentive for efficient water use. However, for many tanks the lack of labor and markets during the dry season limits irrigation.[6] In a few tanks where the labor supply is adequate, farmers at the head of the canal allocate a portion of their land to other farmers (usually friends or relatives) whose lands cannot be reached efficiently by tank water. In one tank farmers were able to use the lands in the head reaches during the dry season because they lost their wet season crop due to flooding. The farmers who "rent" the lands pay no cash rent but help the land owners harvest the wet season rice crop and after the dry season, prepare the land for planting the wet season rice.

Tank <u>operating rules</u>, in addition to those for delivery schedules, are becoming more common. In northeast Thailand rules have been developed which restrict fishing in the tanks either by area or time of the year. Some of the tanks have special fishing days where anyone can fish for a fee. Funds collected in such events are generally used to improve the tanks. Livestock are also being restricted to certain areas of the tanks and fines are levied if livestock are found damaging irrigation structures. Finally rules concerning the contribution of labor and capital for project maintenance are being adopted more widely.

The <u>government's involvement</u> with the tank management is limited. The Government of Thailand (GOT) does not collect water charges from the farmers. Thus, tank water is almost a free good to farmers. The government has tried to improve water use by starting water user organizations (WUO) at each tank. But due to

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[6]Dry season production appears to be limited by uncertain market conditions for many of the dry season crops.

lack of training, funds and other incentives, many of the WUO are inactive. With a future growth in demand for dry season crops likely, GOT has taken steps to improve tank water use through land consolidation and land leveling [Palanisami, 1984b]. The payoff from these investments will depend on collective use of tank water and the opportunity cost of labor in the dry season.

Pattern of Interaction

Given the technical and physical constraints and the decision making arrangements for tank management, it is important to identify the pattern of interaction which characterizes the farmer's behavior in tank management. The primary pattern of interaction in the successful joint use of tank water is reciprocity, which depends upon mutual expectations of positive performance.

South India

Some of the patterns adopted involved a direct substitution of management for scarce water. In three of the ten Indian tanks studied, serious efforts were made to substitute management (which required cooperation) for scarce water. This occurred in Tanks 1, 4 and 9 where the amount spent per acre to improve management was Rs 9.8, 4.7 and 7.4 per acre, respectively. The net benefits per acre due to additional irrigations from improved management were high in these tanks and ranged from Rs 43 to Rs 73 per acre (see Table 3).

Table 3

Return to Water Management in Tank Irrigated Areas, South India, 1982

Tank No.	Water supply level	Amount spent (Rs/acre)	No. of additional irrigations per acre due to management	Value of additional irrigations (Rs/acre)[a]	Net benefits due to additional irrigation (Rs/acre)
1.	Low	9.8	4	80	70
2.	High	0.3	-	-	-
3.	High	0.2	-	-	-
4.	Low	4.7	2	48	43
5.	High	0.4	-	-	-
6.	High	0.5	-	-	-
7.	Low	2.2[b]	1	16	14
8.	Low	2.7[b]	1	18	15
9.	Low	7.4	5	80	73
10.	Medium	1.8	-	-	-

[a]Value of additional irrigations equals the cost of buying well water in the area.

[b]Funds were used to help convey to government a request for additional supplies as specified in previous government agreements.

Source: K. Palanisami and K. William Easter (1983).

Farmers also interact to increase water supplies (see Table 4). Farmers owning wells have established an informal organization which decides the price of ground water based on the expected demand for and supply of ground water during the season.[7] In several cases, tank farmers got together and contributed to a common fund for diverting extra water from other (upper) tanks or streams. The funds collected were used to dig diversion channels and clean the existing channels. In one tank farmers diverted water illegally from a nearby canal. This was done when the water supply in the tank was low during the middle of the crop season. In certain tanks, private pumping is allowed from within the tanks particularly when the water in storage has fallen below the level of the sluice gates. This primarily benefits farmers close to the tank.

The government provides loans and installs community wells to supplement tank water supplies in the wet season and for full irrigation in the dry season. The farmers who benefit from the wells have to pay the operating, maintenance and investment costs. During the wet season a well irrigates around 40 acres but during the dry season a much smaller area is irrigated due to the well capacity constraint. Farmers located close to the

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[7]The well owners are the most influential farmers in the tank. They influence the tank related matters such as opening and closing of the sluices, water allocation schedules and common fund collections. In times of scarcity they even give away their share of the tank water to others. But in several tanks, the well owners constrained tank management with a view to selling their ground water for a longer period at a high price. [For details, see Palanisami and Easter, 1986.]

Table 4

Patterns of Interaction in Tank Served Areas, South India, 1982

Patterns of Interaction	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6	Tank 7	Tank 8	Tank 9	Tank 10
Substitution of management to water	X			X					X	
Cooperation of well owners	X			X						
Diversion of extra water from other tanks, canals etc.	X								X	X [a]
Private pumping from tanks	X			X					X	
Community wells				X					X	
Linking canals to tanks		X					X	X		
Establish informal water users' organization	X			X					X	

[a] This involved the simple cleaning of an existing diversion canal.

community well are encouraged to utilize it during the dry season but must pay the full cost of pumping the water.

Farmers have organized both to support and to oppose the idea of a connecting series of tanks to a nearby large reservoir. Currently there is no connecting channel and water flows from one tank to another in an inefficient manner. In fact, a number of the lower tanks now receive less runoff than they did before the large reservoir was built. Farmers from the lower tanks organized to recommend to the Irrigation Department that they construct a separate canal to deliver water to all tanks simultaneously. In this way upper tanks would get less water but lower tanks would get more. In addition, the improved water distribution would provide a larger effective water supply and total production would increase. This could be structured as a pareto-efficient change by only redistributing excess water from the upper tanks. But as should be expected, without some means of assuring upper tank farmers that they would receive adequate water supplies, particularly in drought years, they organized to oppose the plan.

In a number of cases farmers have also organized at the tank level to ask the state government to remove the trees planted by the State Forestry Department in the tank foreshore areas. This runs counter to the government's program of social forestry but farmers believe that trees reduce the water supply and make desilting difficult.

In several tanks, where the farmers are not organized, the free rider problem is apparent. For example, in tank 10, the water supply was reasonably adequate for the crop season but due to conflicts and lack of cooperation, the water supply was exhausted through repeated unauthorized opening of the sluice gates. Operators farming the foreshore area (encroachers) opened the gates at night to release water and make more foreshore land available for crop production. This caused drainage problems for the farmers in the head-reaches of the command area and low yields throughout the irrigated area. Some of the farmers in the tail-reaches only received two irrigations as compared to eight in the head-reaches because of these unauthorized water releases.

Comparison with Thailand

In contrast to the Indian tanks, the interaction in the Thailand tanks was more limited. It primarily involved the digging of field channels, establishing water delivery schedules and the sharing of land in the dry season. One would expect this situation to change if water becomes scarce or the demand for dry season production increases or both. They may also develop methods for allocating water during unusual drought period much as the farmers did in the primary tanks of south India.

When water is scarce, as it is in many of the Indian tanks, mutual action is required. To allocate water other than by continuous flow requires mutual action and forbearance. In times of water scarcity farmers next to the canals must allow water to flow by their fields and go to their neighbors. Finally, mutual action is the basis for obtaining additional water through water diversion activities, from the digging of channels and from improved system maintenance.

Outcomes (India)

The effect of technical and physical attributes, the decision making arrangements and the pattern of interactions should all be reflected in average crop yields for tank irrigated farmers and the percent of command area irrigated.[8] Both efficiency and equity or fairness can be achieved in tanks where the management level is high. Tanks with higher levels of management should have higher crop yields and a large irrigated area, other things being equal, due to timely and uniform water delivery. Equity is achieved in tanks where farmers with approximately equal sized holdings cooperate in the distribution of water supplies based on farm size (this assumes that the numbers of landless laborers is small).

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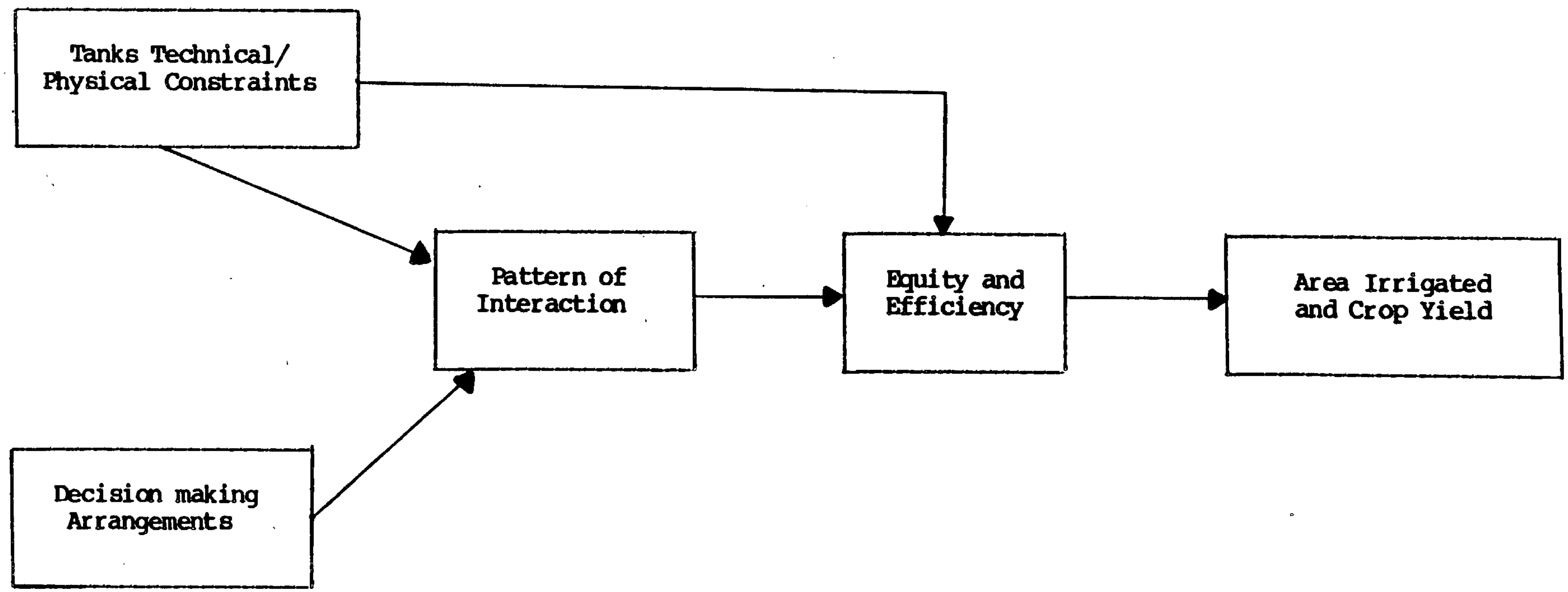
[8]An analysis of rice production in the area served by the ten Indian tanks suggests that fertilizer is the other major input besides water which influences yields. However, the use of a simultaneous equation model shows that tank and well water influence the level of fertilizer applied. Thus, it appears that in this area of uncertain rainfall, water availability and its use are the key determinants of fertilizer use and crop production [Palanisami and Easter, 1983]. Consequently, crop yield and the percentage of command area irrigated should be a good measure of tank performance, when the comparison is made among tanks having about the same per acre water supply. Thus primary tanks 2 and 3 could be compared with each other but they should not be compared with supplementary tanks which have lower water supplies. When crop yields and/or the percentage of command area irrigated are relatively low then performance or outcome is low.

Equity or fairness problems arise when a few large farmers try to dominate water deliveries. Inefficient water use results when head-reach farmers overuse water resulting in water shortages for others. Finally the "tragedy of the commons" is present in tanks where water is scarce and the level of the tank management is poor. The end result involves both losses in efficiency and equity. The water management strategies adopted by the farmers in certain south Indian tanks show how both equity and efficiency can be achieved through improved tank management. The technical and physical attributes of the tanks, the decision making arrangements and pattern of interactions decide the equity and efficiency levels which can be achieved (see Figure 2). These relationships suggest that to achieve a better outcome (area irrigated and crop yield), these three sets of variables should be studied in detail.

The relationships among rice yield, area irrigated and the management variables can only be shown qualitatively (see Table 5). In general there are four tanks, 1, 2, 3 and 9, which had relatively high performance in terms of yield and area irrigated. For two of these tanks, 1 and 9, the performance required good decision making arrangements and patterns of interactions to overcome physical and technical water supply constraints. In the two primary tanks, 2 and 3, the same level of decision making arrangements and patterns of interaction were not needed to achieve high performance because there were no physical or technical constraints in 1982. Tank number 10 is an interesting

Figure 2. Relationship Between Crop Yield, Area Irrigated and Tank Management Variables[a]



[a] In this diagram, the additional variables equity and efficiency specifically influence the area irrigated and crop yield. However, in the model by Oakerson (1981) this is not shown explicitly.

Table 5

Tank Performance and the Level of Water Management, South India, 1982[a]

Tank No.	Physical/ technical constraints	Decision making arrangements	Pattern of interaction	Percent of command area receiving water	Rice yield (Q/ac)[d]
1.	Medium	Good	Active	84	13.8
2.	Low	Adequate	--	99	16.7[b]
3.	Low	Adequate	--	97	14.5[b]
4.	High	Good	Active	85	11.0[c]
5.	High	Poor	--	58	15.8
6.	High	Poor	--	21	14.8
7.	High	Poor	--	88	11.1
8.	High	Poor	--	90	11.6
9.	Medium	Good	Active	93	14.5
10.	Low	Poor	--	88	12.6

[a]The grouping of the variables low, medium and high, and good, adequate and poor are based on their overall performance during the 1982 study. The grouping is based on factors discussed in the Palanisami and Easter report, 1983.

[b]These tanks are primary tanks and receive additional water from perennial sources.

[c]The yield is low due to very low 1982 rainfall. The community well in this tank covers only a small area in the total command area.

[d]The yields are for the area irrigated and not the total command area.

SOURCE: K. Palanisami and K. William Easter, 1983.

example of a tank with few physical and technical constraints but low performance. The lack of cooperation among farmers led to a misuse of the abundant water supply which resulted in relatively low yields. In tank 4 the severe water supply constraint kept yields low even with good decision making arrangements and patterns of interaction. For tank 5 and 6 performance was poor because of design problems which prevented irrigation of the full command area. Finally farmers served by tanks 7 and 8 faced a water supply constraint and were able to obtain additional water allocations. Yet they could not organize effectively to make better use of the available water.

Conclusion

Management of the tank irrigation systems in south India and northeastern Thailand is influenced by technical and physical factors. Several decision making arrangements (rules) are required to effectively manage the tanks as a common property resource. Farmers' interactions to adopt decision rules are needed to achieve equity and efficiency in water use which in turn results in higher crop yield and a greater area irrigated. The following actions would help improve tank management as common property resources: (a) identify the technical and physical constraints for each tank or group of tanks so that efforts to improve tank management can focus on strategies to relax these constraints; (b) encourage formal and informal water user organizations by providing incentives in terms of technical assistance, training, legal authority and funds for organization;

(c) transfer ownership of tanks from the government to farmers once they are organized into viable WUO. This can reduce the government burden involved in collecting water fees from the farmers and in allocating funds for tank management, which are currently inadequate. Such a decision will represent a property-enhancing strategy at the community level [Coward, 1986]. By assisting the local community in their property-enhancing strategy, the government could induce further tank related investments by the farmers.[9]

[9]In northeast Thailand the involvement of the local community in construction of diversion weirs for irrigation has been a property-enhancing strategy. [For more details, see K. Palanisami, 1984a.]

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